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Massen

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[54] METHOD AND DEVICE FOR SORTING MATERIALS

[76] Inventor: Robert Massen, Am Rebberg 29, 78337 Öhningen, Germany

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[58] Field of Search 209/524, 576, 209/577, 580, 585, 587, 588, 589

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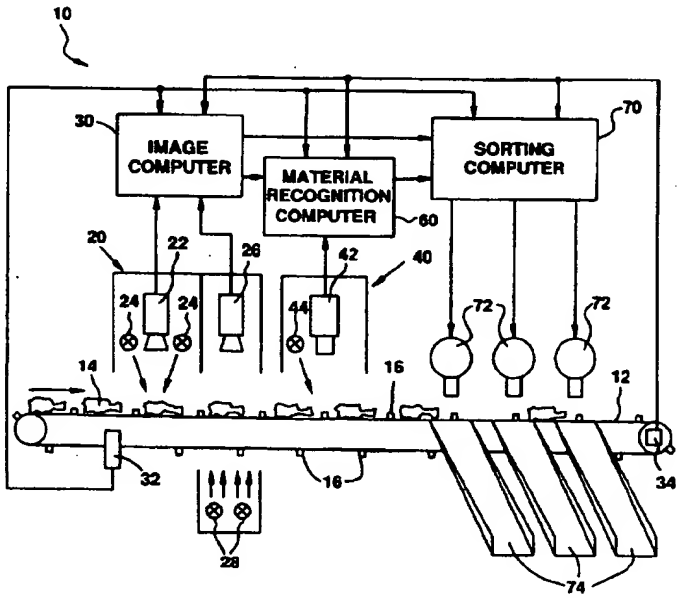
Primary Examiner—David H. Bollinger
Attorney, Agent, or Firm—Sixbey, Freidman, Leedom & Ferguson, P.C.; Gerald J. Ferguson, Jr.; Tim L. Brackett, Jr.

[57] ABSTRACT

To sort materials, in particular plastic parts, the items are carried at known conveying speed past a material recognition system which uses non-contact scanning, for example NIR spectroscopy, of each item to determine its material type and delivers a signal that identifies the type of material, which signal is used in sorting the items according to material type. To ensure that the determination of material type is done at a spot on the item that is not disturbed by a label, metal stamp or the like, the items are also conveyed past an imaging system which takes pictures of the items from which, using electronic image-processing techniques, features of colour and/or shape of the items are determined, from which in turn position data are derived about spots on the item at which an undisturbed determination of material type is possible. With the aid of these position data the determination of material type is then confined to such undisturbed spots.

23 Claims, 4 Drawing Sheets



executed by electronic time-delay elements. Subsequently, the image computer **30** again determines colour and shape features and determines the position of spots on the items, which are appropriate for undisturbed determination of the type of material. The position data supplied by the image computer **30** is again conveyed to the material recognition computer **60** and can be converted on the basis of the known conveying speed of the conveyor belt **12** and the known distance between the material recognition system **40** and the imaging system **20** to the positions which the spots concerned had occupied previously whilst the type of material was being determined in the material recognition system. Since the measuring results are stored in the memory of the material recognition computer **60**, as allocated to these positions, this memory can be addressed by the converted position data in such a way that the measuring results are read out which originate from the spots which were found to be suitable by the image computer **30** and identified by the position data. These measuring results are supplied to the sorting computer **70** in the same way as for the sorting system of FIG. **1**, and said sorting computer **70** controls the sorting points **42** according to the set sorting criteria, in the way described previously.

With the embodiment of FIG. **4**, it is not possible to direct the measuring field **48** of the material sensor **42** by deflecting it to specific spots, on the basis of the position data supplied by the image computer **30**, as shown in FIG. **3**, because this measure assumes that the imaging system is arranged ahead of the material recognition system. Apart from this, the embodiment in FIG. **4** offers the same facilities for sorting the items as that of FIG. **1**.

FIG. **5** depicts a further embodiment of the sorting system, which shows in particular, how the data obtained by processing the images in the image computer **30** can be beneficially used for further purposes. The embodiment of FIG. **5** represents an extension of the embodiment of FIG. **1**; it contains all the components of the embodiment of FIG. **1**, which are designated with the same reference symbols as in the latter. In addition, in the case of the embodiment of FIG. **5**, two additional stations, **80** and **90**, through which the items **14** are conveyed, are inserted between the material recognition system **40** and the sorting points **72** along the conveyor belt **12**.

Station **80** is used to separate out items made from glass, i.e. in the case of the example chosen of sorting hollow bodies, in particular glass bottles and other glass containers. The weight of each hollow body **14** is determined by a rapid belt scale **82** and entered in a computer **84**. From the weight alone, it is not possible to distinguish between glass and plastic containers, if the dimensions of the hollow body are not known. Therefore, data regarding features of shape are transmitted by the image computer **30** to the computer **84** and from these data, the computer **84** can estimate the size of the hollow body. By linking the weight and geometrical size, the computer **84** decides whether the item in question is a glass body or a plastic body. The computer **84** then controls a sorting point **86** in such a way, that the glass bodies are separated by an eject device **88**. The sorting point **86**, as shown in FIG. **5**, may be located immediately next to station **80**. However, it may also be added to the sorting points **72** at the end of the conveyor belt **12**; in this case, the computer **84** delivers to the sorting computer **70** data, which identify the positions of recognized glass bodies, so that the sorting computer **70** can separate out the glass bodies by operating the appropriate sorting point. As a rule, it is advantageous to combine all the eject stations at the end of the conveyor belt and to set them up in close proximity to one another. Synchronization is easily achieved by the sorting computer **70**, since from the position data supplied by the various stations, the known belt speed and the known distances between the stations and the sorting points, the moment when the sorting points are to be operated can be precisely determined.

The station **90** is a separating station, where the sealing caps **52** and the base cups **56** are separated from the bottle bodies **50** and ejected. A computer **92** receives position data from the image computer **30** regarding the positions of sealing caps **52** and base cups **56** on the hollow bodies **50**, and from the material recognition computer **60** data about the types of material of these components. On the basis of these data, the computer **92** decides whether a sealing cap and/or a base cup is to be separated, and at the right moment when the hollow body **50** is passing, it triggers a separation device **94**, which separates the part in question and ejects it via an eject station **96**.

It can therefore be seen that in the additional stations **80** and **90**, as in the material recognition system **40**, the features of shape and colour and position data obtained by image processing in the image computer **20** are also used for concerted sorting.

Naturally, additional stations can be added to the sorting system of FIG. **5**, if required. A particular advantage of the invention consists in the fact that the sequence of stations is arbitrary, since the functions of the stations are controlled on the basis of the position data which can be calculated for each station independently of the others.

Further modifications, with which the expert is familiar, can of course be made to the sorting systems described. For example, instead of a conveyor belt, any other known means of conveying may be used which is capable of conveying the items through the various stations without slipping, for example, a rotating table. Furthermore, the functions of various computers which are shown separately in the drawings for the sake of clarity, may be carried out by one common computer.

I claim:

1. A method for sorting materials, in particular plastic parts, comprising:

conveying items at known conveying speed past a material recognition system which uses non-contact scanning of each item to determine its material type in a measuring field and delivers a signal that identifies the material type and is used in sorting the items according to material type;

conveying the items past an imaging system which takes pictures of the items;

detecting features of colour and/or shape of the items from the pictures using electronic image processing techniques;

deriving position data from the features of colour and/or shape regarding spots on the item at which an undisturbed determination of the material type is possible without disturbance by other material types; and

determining the material type using the material recognition system, wherein determination of the material type is confined to such undisturbed spots as identified by the position data.

2. The method according to claim **1**, wherein the imaging system in the direction of conveyance of the items is located ahead of the material recognition system.

3. The method according to claim **2**, wherein determination of the material type is triggered by the material recognition system when an undisturbed spot of an item, identified

by the position data, is located in the measuring field of the material recognition system.

4. The method according to claim 2, wherein the position data are used for controlling a deflection system, so that the measuring field of the material recognition system is directed towards an undisturbed spot on the item.

5. The method according to claim 2, wherein the illumination of the items by radiation necessary to determine the material type, is limited to the undisturbed spots identified by the position data while the measuring field of the material recognition system covers a larger area of the items.

6. The method according to claim 2, wherein of all the signals supplied by the material recognition system, only those are utilized as being valid which originate from undisturbed spots identified by the position data.

7. The method according to claim 1, wherein the material recognition system, in the direction of conveyance of the items, is located ahead of the imaging system, the signals supplied by the material recognition system are stored and of the stored signals only those are utilized as being valid, which are allocated to the undisturbed spots as identified by the position data.

8. The method according to claim 1, wherein the measuring field of the material recognition system is deformed by optical systems in such a way that, in the direction of conveyance, it has a high local resolution compared with the transverse direction.

9. The method according to claim 1, wherein the measuring field of the material recognition system is divided by optical elements and/or fibre optics in such a way that it covers the items at various spots according to a spatial pattern.

10. The method according to claim 9, wherein the spatial pattern is determined by the distribution of the illumination of the items using radiation necessary to determine the material type within the measuring field.

11. The method according to claim 9, wherein the spatial pattern is selected in such manner that it simultaneously detects several spots on the items which are significant for determining the material type.

12. A device for sorting materials, in particular plastic parts, comprising a conveying device for the slip-free conveyance of the items at a known speed, an imaging system past which the items are conveyed and which takes pictures of the items and converts these into electrical image signals, an image computer which determines features of colour and/or shape of the items from the electrical image signals, a material recognition system past which the items are conveyed and which contains a material sensor for non-contact scanning of each item in a measuring field and a material recognition computer which by processing the output signals of the material sensor determines the material type in the measuring field and delivers a signal that identifies the material type, and a sorting device which sorts the items on the basis of the signals supplied by the imaging system and by the material recognition system according to fixed sorting categories, wherein the image computer derives, from the features of colour and/or shape obtained, position data about spots on the items at which an unequivocal determination of material type is possible without disturbance by other material types, and wherein the material recognition computer receives the position data from the image computer and, based on the position data received, confines the determination of the material type to the undisturbed spots identified by the position data.

13. The device according to claim 12, wherein the imaging system contains a colour video camera which takes pictures of the items in incident light.

14. The device according to claim 12, wherein the imaging system contains a colour video camera which takes pictures of the items in transmitted light.

15. The device according to claim 14, wherein each colour video camera is a line or matrix camera.

16. The device according to claim 12, wherein the material sensor is an NIR spectroscopic sensor.

17. The device according to claim 12, wherein the imaging system, in the direction of conveyance of the items, is located ahead of the material recognition system.

18. The device according to claim 17, wherein an optical deflection device is located in the path of the light beam that determines the measuring field, said deflection device being controlled by the material recognition computer on the basis of the position data supplied by the imaging system in such a way that the measuring field is directed to an undisturbed spot on the item, as identified by the position data.

19. The device according to claim 18, wherein the optical deflection device is a mirror galvanometer.

20. The device according to claim 12, wherein the imaging system, in the direction of conveyance of the items, is located behind the material recognition system and the material recognition computer contains a memory in which all the signals supplied by the material sensor are stored and which is read out by addressing it by the position data supplied by the image computer.

21. The device according to claim 12, wherein a sorting computer is assigned to the sorting device and this computer receives data from the image computer and from the material recognition computer and controls the sorting of the items, on the basis of these data, according to sorting categories determined by set sorting criteria.

22. The device according to claim 12, comprising a station located on the conveying device for separating out glass bodies using a belt scale measuring the weight of the items, and an associated computer which receives data from the image computer about shape features, which enable the size of the items to be determined, and which detects present glass bodies on the basis of the size and weight measured.

23. The device according to claim 12, comprising a station located along the conveying device for separating components of the items using a separating device, and a computer controlling the separating device, which receives position data from the image computer about the components to be separated.

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